MATHEMATICAL KNOWLEDGE FOR TEACHING (MKT) AMONG PRIMARY SCHOOL TEACHERS OF FIJI

By

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ABSTRACT

Primary School Teachers in Fiji are employed and supervised by the Ministry of Education and are expected to teach all subjects prescribed by the Ministry with necessary teacher qualification. The objectives of the study is to examine the current status of MKT for Primary School Mathematics Teachers in Fiji schools in terms of its components; Knowledge of Content and Students (KCS); Knowledge of Content and Teaching (KCT); Common Content Knowledge (CCK); and Specialized Content Knowledge (SCK), and to compare status of MKT (Mathematical Knowledge for Teaching) for primary schools teachers, with gender. The study engages descriptive survey with engagement of Stratified Random Sampling technique with sample size of 363 Primary School Teachers, from each stratus covering the four major Divisions; Northern, Central, Western, and Eastern and uses a test on MKT to gauge the levels of teachers' MKT and t-test analysis is used to analyse the data quantitatively. The relevance of the study is to give a sense of direction to the Ministry of Education in Fiji, on how to support primary school teachers with teaching and other related assistance, to bring about higher achievement in mathematics assessments, and more importantly, meaningful learning for students. Finally, the study allows dialogue of different college teachers on the notions of MKT and incorporate in mathematics education courses. The findings of the study are discussed in detail in the paper.

Keywords: Mathematical Knowledge for Teaching, Primary School Teachers, Common Content Knowledge, Knowledge of Content and Teaching, Knowledge of Content and Students, Specialised Content Knowledge.

INTRODUCTION

One of the key goals for education policymakers is to improve the education system and to ensure that relevant curriculum be in place to bring about positive outcomes in students' learning. For the accomplishment of the highlighted goal many researchers agree that teachers' knowledge needs to be the focus, in terms of content and pedagogical aspects of teaching (Ono and Ferreira, 2010). Significant work has been done over the past decade in trying to understand teachers' content knowledge, values, and skills finely woven with classroom practice, to bring about effective teaching.

Mathematical Knowledge for Teaching

Mathematics Knowledge for Teaching includes the knowledge that teachers need 'in' teaching Mathematics and 'for' teaching mathematics as defined by Schneider and Plasman (2011), to enable one to teach mathematics more effectively.

The Mathematics Knowledge for Teaching (MKT) concept has been initially derived from Shulman's (1986) experimental model and further modified to a more inter-related components of teachers' MKT which was further designed by Hill et al. (2008) and been labelled as one of the most exceptional re-organised structures of the teachers' Pedagogical Content Knowledge, within mathematics education arena.

Shulman's Model highlighted the two major components in teaching mathematics, as Procedural Content Knowledge and Subject Content Knowledge which was later

elaborated by Hill et al. (2008) and rephrased as Mathematical Knowledge for Teaching (MKT), categorising two major areas as Subject Matter Knowledge and Pedagogical Content Knowledge, which are further sub-divided. Subject Matter Knowledge, includes Specialised Content Knowledge (SCK), Common Content Knowledge (CCK), and Horizon Content Knowledge (HCK). On the other hand, Pedagogical Content Knowledge covers Knowledge of Content and Teaching (KCT), Knowledge of Content and Students (KCS), and Knowledge of Content and Curriculum (KCC).

Basically SCK covers knowledge of content limited to teaching mathematics which gives opportunity for preparations for teaching using relevant resources, representations and making connections, attending to student responses and using mathematical language for teaching. CCK gives way for teachers to focus on mathematical knowledge that is needed to solve problems in multi-contexts to meet the needs of the community and society at large. HCK, on the other hand, expects teachers to relate mathematics topics across the curriculum, and also mapping mathematical concepts with other levels or grades.

Alternatively, Pedagogical Content Knowledge includes KCT, which requires teachers make connections of mathematical concepts and ideas with pedagogical approaches which brings about meaningful and effective learning in students. KCS focuses on teachers' understanding on mathematical content interacting with how students think, and at times addressing students' misconceptions. KCC, directs teachers to connect mathematical content with teaching resources. KCC and HCK are normally embedded within the other highlighted components.

The use of MKT as a modified Shulman's model is seen as a more holistic model that would measure teachers' mathematical knowledge for teaching from a more wider perspective, and it provides a direct relationship between teachers' Procedural Content Knowledge with student learning.

Research has proven that MKT is positively associated with students' mathematics achievement (Ball et al., 2008; Hill et al., 2008) as teachers teach the content with conceptual understanding (Tchoshanov, 2011), using high quality cognitive tasks (Charalambous, 2010).

1. Need and Importance of the Study

According to Muralidhar (1989), one of the reasons the students do not perform well in mathematics in Fiji, is due to the teaching pedagogies used by teachers; traditional approach whereby mathematics ideas are taught to students in exactly the same way to all students, despite the differences in students' learning styles, which was earlier researched by Raj (1985), as students lack mathematics abilities and attitudes due to how mathematics is taught, resulting to reluctance to do extra if not guided by step by step procedures.

In addition, as according to the one of the local newspapers in Fiji, The Fiji Times, dated December 3rd 2016, the former Education Minister, Dr. Mahendra Reddy had blamed the failure of the primary school system and subject delivery as the main contributors to the drop in Year 6 and 8 National Examination results as the pass rate for Mathematics for Year 6 in 2016 was only 29 percent, which is relatively very low. The Minister added, that it is the opportune time to look at new strategies of subject delivery.

Moreover, Fiji's population is almost about 900,000 and is categorised under 'Small Island States' category, and since research literature for small islands states are not plentiful, Sanga's (2012) findings of such studies can be used as building blocks of local and international literature in mathematics education.

2. Resume of the Related Literature

Ghousseini (2017) highlighted that rehearsals on MKT, using repeated cycles of varied activities with related instructional procedures, supports teachers' MKT, and builds up confidence in teaching mathematics.

Raveh et al. (2016) revealed that connectionist framework for teaching basic four operations in algorithms supports primary teachers' SCK, and could connect essential components of knowledge of teaching algorithms, thus could be useful in planning and unpacking teaching goals in algorithms, making connections within the topics and other topics in mathematics, resulting to thorough

understanding.

Turner (2012) revealed that Knowledge Quartet (KQ) framework supports reflection on teaching and development of teachers' MKT through collaboration of lesson observations, interviews, and reflections. Other uses of KQ is thorough reflection of collaborative dialogues; critical evaluation of planning and teaching; which could also become the basis of reflective Framework.

Ng (2011) highlighted that teachers with better MKT were teachers with higher education attainment; and broader range of classes taught. Recommendations included teachers' minimum requirement for education degrees to be four years, and provision for mathematics specialists.

Charalambous et al. (2010) revealed that there is positive relationship between teacher's MKT and teacher's cognitive level at which the tasks were prepared and implemented.

Hill et al. (2008) highlighted the impact of MKT on quality of teachers' instruction, which confirms positive association. Other findings, include attitude, resources, and the impact of PD sessions supported teachers' MKT instruction.

Hill et al. (2005) revealed that teachers with MKT have acquired high quality instruction, not specifically on MKT, but also contribute to general knowledge about teaching. Quality teachers' MKT positively contribute to quality mathematics content knowledge, resulting to higher student achievement.

After a critical analysis of the related literature findings, the following questions arose in the mind of the researcher:

- What are current status of MKT for Primary School Mathematics Teachers in Fiji schools in terms of its components; Knowledge of Content and Students (KCS); Knowledge of Content and Teaching (KCT); Common Content Knowledge (CCK); and Specialized Content Knowledge (SCK)?
- Whether MKT of Primary School Mathematics Teachers in Fiji differ, with respect to gender?

To find answers to these questions, the present study, titled "Mathematical Knowledge for Teaching among Primary School Teachers of Fiji" was undertaken.

3. Operational Definitions of the Terms

3.1 Mathematical Knowledge for Teaching (MKT)

Mathematical Knowledge for Teaching refers to what mathematical techniques and skills that teachers require to teach mathematics, and can be divided into two categories; Pedagogical Content Knowledge (PCK) according to Hill et al. (2008), includes Knowledge of Content and Students (KCS), which refers to knowing about the students and mathematics; and Knowledge of Content and Teaching (KCT), knowing about teaching and mathematics.

The other category; subject matter knowledge includes Common Content Knowledge (CCK), mathematical skills and knowledge, which can be used in realistic situations and Specialised Content Knowledge (SCK), refer to mathematical skills and knowledge, more confined to teaching. The other two components of MKT; Knowledge at the Mathematical Horizon (KMHZ), and Knowledge of Content and Curriculum (KCC) are usually embedded in the other categories of MKT.

In the present study, the researcher expounded on Hill et al.'s model (2008) of the levels of MKT with its related components for Primary School Mathematics Teachers in Fiji, which was measured by administering a 'Test on Mathematics Knowledge for Teaching' which was prepared by the researcher by covering the following:

(i) Common Content Knowledge,

(ii) Knowledge of Content and Teaching,

(iii) Knowledge of Content and Students

(iv) Specialised Content Knowledge

3.2 Primary School Mathematics Teachers

In the present study, Primary School Mathematics Teachers refer to male and female teachers in Fiji serving in different schools in various locations throughout the country, currently serving at 731 primary schools in Fiji, and are basically divided into four main divisions, namely; Central, Northern, Western, and Eastern division, whereby the schools are further categorised as remote, rural, semi-urban, and urban schools. According to Ministry of Education Report in 2011, rural schools are classified under 10 to 20 km from a town boundary; and remote are greater

than 20 km away; for this study, the researcher has categorised semi-urban, 4 km to 9 km from town boundary; and urban, within 3 km within town boundary.

Primary School Mathematics Teachers are directly employed and supervised by the MOE with a minimum qualification of Primary Teacher Certificate and are required to teach all the subjects prescribed by MOE.

4. Objectives of the Study

- To study the level of Mathematical Knowledge for Teaching of Primary School Mathematics Teachers of Fiji and its components; Common Content Knowledge, Knowledge of Content and Teaching, Knowledge of Content and Students, and Specialised Content Knowledge.
- To compare the level of Mathematical Knowledge for Teaching among Primary School Mathematics Teachers, with respect to gender.
- To compare the level of Mathematical Knowledge for Teaching Components among Primary School Mathematics Teachers with respect to gender.

5. Hypothesis of the Study

- Male and female Primary School Mathematics Teachers differ significantly in Mathematical Knowledge for Teaching.
- Male and female Primary School Mathematics Teachers differ significantly in Mathematics Knowledge for Teaching components.

6. Methodology

The population covers all Primary School Mathematics Teachers in Fiji, which has a total of 5974 teachers in 2016, as the data given by the Ministry of Education.

The sample was obtained using Krejcie and Morgan in 1970 sample size table.

Descriptive survey was used with engagement of Stratified Random Sampling technique, whereby a strata from each Education District is selected, from the four Education Districts; Northern, Central, Western, and Eastern.

The research tool used was validated using Content Validity, whereby the tool was validated by a group of experts in the field of educational research.

7. Analysis of Data and Results

The collected data were tabulated, analysed, and interpreted using Statistical Package for the Social Sciences (SPSS).

7.1 Objective 1

To study the level of Mathematical Knowledge for Teaching of Primary School Mathematics Teachers of Fiji and its components; Common Content Knowledge, Knowledge of Content and Teaching, Knowledge of Content and Students, and Specialised Content Knowledge.

The data collected by administering the tool 'A Test on Mathematics Knowledge for Teaching' was analysed by calculating the mean, standard deviation, and percentage. The teachers were categorised levels:

High MKT Level - Teachers who have MKT score which is greater than mean + 1SD

Average MKT Level - Teachers who have MKT score which is between mean +1SD to mean – 1SD.

Low MKT Level - Teachers who have MKT score which is less than mean - 1SD. Percentage of MKT and percentage of MKT components, with respect to each level of teachers are given in Tables 1 and 2, respectively.

Table 1 indicates that 63.9% of the teachers have average level of MKT. Hence it can be concluded that Primary School Mathematics Teachers of Fiji have average level of MKT.

Table 2 indicates that 72.5% of teachers have average level of CCK as highest; 65.6% of teachers have average level of KCT as highest; 64.7% of teachers have average level of KCS as highest; and 61,7% of teachers have average level of SCK as highest. Therefore, it can be concluded that Primary School Teachers in Fiji have an average level of MKT components, whilst CCK being the highest among the Primary School Mathematics Teachers with average level of MKT.

Level of MKT	N	%
High	63	17.4%
Average	232	63.9 %
Low	68	18.7%

Table 1. Percentage of MKT of Primary School Mathematics Teachers in Fiji

MKT Components	Level	N	%
CCK	High	54	14.9%
	Average	263	72.5%
	Low	46	12.7%
KCT	High	67	18.5%
	Average	238	65.6%
	Low	58	16.0%
KCS	High	79	21.8%
	Average	235	64.7%
	Low	49	13.5%
SCK	High	69	19.0%
	Average	224	61.7%
	Low	70	19.3%

Table 2. Percentage of MKT Components of Primary School Mathematics in Fiji

To compare the level of MKT, with respect to gender, the reliability of the data was calculated using Cronbach's Alpha. The details are given in Table 3.

7.2 Objective 2

To compare the level of Mathematical Knowledge for Teaching among Primary School Mathematics Teachers with respect to gender.

The hypothesis was formulated from the objective.

7.2.1 Hypothesis 1

H_1: Male and female Primary School Mathematics Teachers differ significantly in MKT.

To test the hypothesis, it was changed into null hypothesis as stated below.

H_0: Male and female Primary School Mathematics Teachers do not differ significantly in MKT.

The hypothesis was tested using 't-test' with the level of significance fixed at 0.05 level. The details are given in Table 4.

Table 4 indicates that the t-value is 2.25, and P value of .025, which is significant at 0.05 level, thus the null hypothesis is rejected. Therefore it can be concluded that there is a significant difference between male and female teachers in the level of MKT. From Table 4, it is also revealed that the mean score for male teachers, which is 52.96, and is higher than female teachers with the mean of 50.32 thus it can be concluded that male teachers' level of MKT is significantly higher than female teachers.

Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	No. of Items
.746	.750	8

Table 3. Reliability Details of Data with Respect to Gender

7.3 Objective 3

To compare the level of Mathematical Knowledge for Teaching Components among Primary School Mathematics Teachers with respect to gender.

7.3.1 Hypothesis 2

Male and female Primary School Mathematics Teachers differ significantly in MKT components.

H_1: Male and female Primary School Mathematics Teachers differ significantly in MKT components.

To list the hypothesis, it was changed into null hypothesis as stated below.

H_0: Male and female Primary School Mathematics Teachers do not differ significantly in MKT components.

The hypothesis was tested using 't-test' with the level significance fixed at 0.05 level. The details are given in Table 5.

Table 5 indicates that the t-value of CCK is 1.376 and P-value of .170, which is not significant at 0.05 level, thus the null hypothesis is accepted. Therefore it can be concluded that there is no significant difference between male and

	Gender	Mean	Std. Deviation	t	P value	Result
MKT	Male	52.956	10.8576	2.25	.025	Significant at 0.05 level
	Female	50.445	10.3227			

Table 4. 't-test' details of MKT among Male and Female Primary School Mathematics Teachers of Fiji

MKT Component	Mean		t- value	P-value	Results N or NS
	Males	Females			
CCK	14.8177	14.4254	1.376	.170	NS
KCT	12.9834	12.2099	2.606	.010	S
KCS	12.7348	12.1768	1.651	.100	NS
SCK	12.4199	11.5691	2.125	.035	S

Table 5. 't-test' details of MKT Components amongst Male and Female Primary School Mathematics Teachers in Fiji

female teachers in the level of CCK. In addition, the t-value of KCT is 2.606 and P - value of .010, which is significant at 0.05 level, thus the null hypothesis is rejected. Therefore, it can be concluded that there is a significant difference between male and female teachers with the level of KCT. Furthermore, the t-value of KCS is 1.651 and P value is .100, which is not significant at .05 level, thus the null hypothesis is accepted, which confirms that there is no significant difference between male and female teachers in the level of KCS. Moreover, the t-value of SCK is 2.125 and P-value of .035, which is significant at .05 level, thus the null hypothesis is rejected. Therefore, it can be concluded that there is a significant difference between male and female teachers with the level of SCK. Hence, it can be concluded that Teachers differ significantly with respect to KCT and SCK components of MKT, but with respect to CCK and KCS they do not differ significantly.

8. Major Findings of the Study

- Primary School Mathematics teachers in Fiji have an average level of Mathematical Knowledge for teaching.
- Primary School Mathematics teachers in Fiji have an average level of Mathematical Knowledge for Teaching components. Common content was highest and Specialised Content Knowledge was the least, aiming at teachers with the average level of Mathematical Knowledge for Teaching.
- Male teachers' Mathematical Knowledge Teaching is significantly higher than that of female teachers.
- Male teachers' level of Knowledge of Content and Teaching is significantly higher than that of female teachers.
- Male teachers' level of Specialised Content Knowledge is significantly higher than that of female teachers.

9. Educational Implications

In order to improve the average level of Mathematical Knowledge for Teaching and its components among Primary School Mathematics teachers in Fiji, the Ministry of Education need to:

- Support teachers in providing professional development sessions on Mathematical Knowledge for Teaching and its components.
- Invite resource personnel to run workshops in Mathematical Knowledge for Teaching.
- To review and develop resource materials in Primary Mathematics that are aligned with Mathematical Knowledge for Teaching.
- Form clusters and teachers' network, to allow for teachers to share ideas on Mathematical Knowledge for Teaching.
- Review time allocated for teaching mathematics in the class time table.
- Review class size for each class.

To increase level of Mathematical Knowledge for Teaching amongst female teachers, the Ministry of Education need to:

- Conduct more training for female teachers on Mathematical Knowledge for Teaching.
- Allow female teachers to teach wider range of classes.
- Encourage female teachers to build up network with other female teachers to share Mathematical Knowledge for Teaching ideas.
- Encourage female teachers to become specialist mathematics teachers in primary schools.

To increase the level of Knowledge of Content and Teaching and Specialised Content Knowledge, of female teachers, the Ministry of Education needs to:

- Conduct PD sessions for female teachers addressing Knowledge of Content and Teaching and Specialised Content Knowledge.
- Invite resource personnel to facilitate Professional Development sessions on Knowledge of Content and Teaching and Specialised Content Knowledge.
- Encourage female teachers to design Knowledge of Content and Teaching and Specialised Content Knowledge tasks.
- Encourage female teachers to test out designed tasks which could be part of one's action research.
- Allocate funds to develop resource materials that are related to Knowledge of Content and Teaching and

Specialised Content Knowledge, whereby female teachers could be actively engaged in such related projects.

Conclusion

Mathematical Knowledge for Teaching is not another 'black box' to teaching mathematics, however, it requires a more genuine re-organisation in the teaching of mathematics. Once Mathematical Knowledge for Teaching is well addressed at the primary school level, there would be positive changes as teachers' cognitive level of teaching task preparations and its implementation would be of high quality which results to quality teacher instruction, well prepared resources and brings about positive attitude in teaching mathematics. Teachers, therefore, would not only acquire quality instruction on Mathematical Knowledge for Teaching, but would also contribute to general knowledge about teaching. Quality teachers' Mathematical Knowledge for Teaching would also contribute to quality mathematics content knowledge, resulting to higher student achievement. Some of the strategies that could be useful to improve teachers' Mathematical Knowledge for Teaching are; the use of rehearsals, connectionist framework concept, and the use of Knowledge Quartet (KQ) framework.

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